

ATLAS Standard Model Working Group *Introduction*

ATLAS Physics Workshop
Athens, Greece
May 22, 2003

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Overview



- Previous Sessions: Heavy Ions & Forward Physics
- This session:
 - ✿ introduction (this talk)
 - Survey of ongoing work within the SM group
 - ATLAS commissioning with physics signatures
 - First SM measurements with ATLAS
 - ✿ minimum bias and the underlying event (A. Moraes)
 - ✿ PDFs for the first year of ATLAS Physics
(J. Butterworth, with contributions from S. Ferrag, N. Skatchkov)
 - ✿ WW scattering (B. Cox)
 - ✿ Wavelet Analysis of VHM Events (V. Uzhinsky)

ATLAS S.M. Group 'Mission Statement'

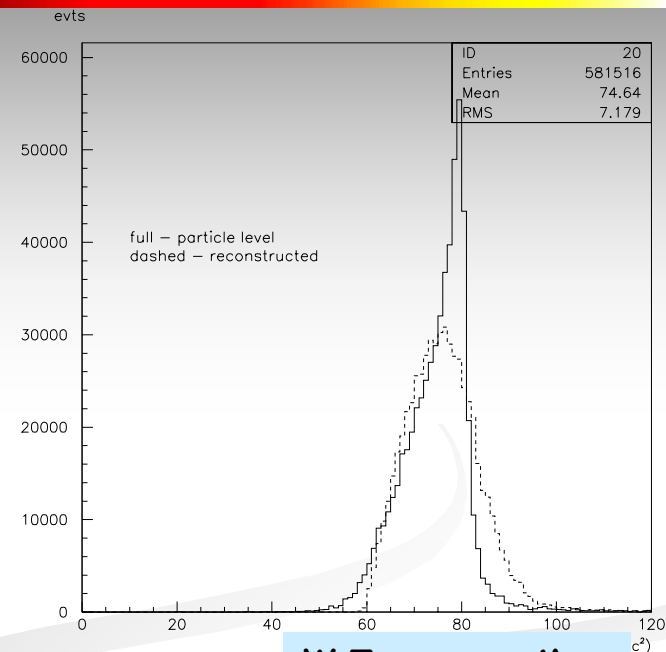


- encompasses all Standard Model physics *except* Top, Beauty, and Higgs. (nominally includes heavy ions)
 - (First SM meeting was Feb 2002)
- In the first year(s) of collisions we'll focus on
 - ⊗ analyses relevant for detector commissioning
 - in close collaboration with the performance groups.
 - ⊗ verifying (and establishing!) our underlying assumptions
 - PDFs, Monte Carlos, min. Bias & underlying event,...
 - driven by new searches and in collaboration with MC experts
 - ⊗ This will be the arena in which we PROVE our understanding of the detector and physics environ.
 - Supporting the new discoveries.
- *Beyond the first year(s):*
 - ⊗ Key precision measurements: $M(W)$, $\Gamma(W)$, $\sin^2\theta_W$, $\alpha_s(Q^2)$, TGC's
 - drives performance studies. Requires perfectly understood detector.
 - indirect constraints ...
 - ⊗ previously unseen SM phenomena
 - tri-boson production $pp \rightarrow VVV$, gauge-boson scattering, QGCs, ...

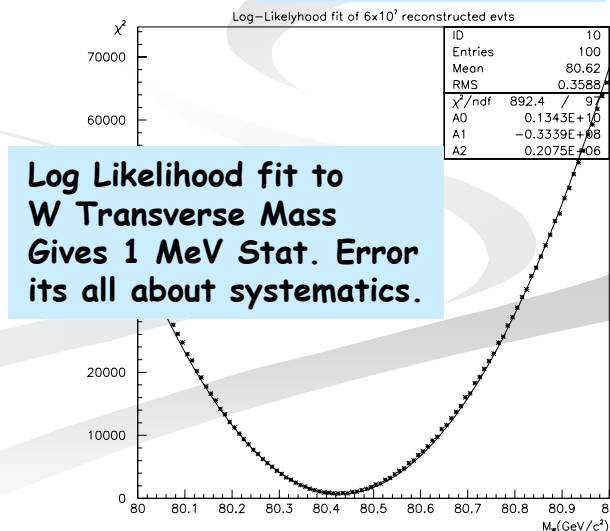
Ongoing Studies



- **W mass and width**
 - analysis change up and running - focus now on systematics
→ M. David, C. Marques, A. Maio (Lisbon)
- **$P_T(Z \rightarrow e^+e^-)$ distribution**
 - probe QCD with well understood EW phenomena
 - test new theoretical advancements in extrapolation b/t perturbative and non-perturbative regimes (Zhang, Quid, Berger 2001-2)
 - P. Staroba (Prague)
- **di-jet production at high Q^2 (see PDF talk)**
 - exotic searches is primary motivation
 - early user of CTEQ PDF's with errors.
 - provides measure of $\alpha_s(Q^2)$
→ S. Ferrag (in2p3)
- **γ + jet for measuring PDF(G) (see PDF talk)**
→ N. Skatchkov / D. Bandurin (Dubna)



W Transverse Mass



**Log Likelihood fit to
W Transverse Mass
Gives 1 MeV Stat. Error
its all about systematics.**

Ongoing Studies: Status of the NLO WG at KEK

S. Odaka (KEK)



<http://atlas.kek.jp/physics/nlo-wg/index.html> and <http://atlas.kek.jp/physics/nlo-wg/grappa.html>

■ LO generators in the GR@PPA framework

- ⊗ **GR@PPA_4b** (all SM 4 b-quark productions)
 - Version 1.06 release in Apr., 2002. → S. Tsuno et al., Comput. Phys. Commun, 151 (2003) 216
 - The PYTHIA approx. for **pure QCD** processes used in a Phys. TRD analysis was found to be reasonable (ATLAS MC meetings).
 - **Version 2.01** release on the Web page in Apr., 2003.
 - ⊗ Les Houches external generator interface, PYTHIA 6.2 and HERWIG 6.5 embedding
 - ⊗ (Preliminary) support of LHAPDF
- ⊗ **GR@PPA_All** (collection of GR@PPA-based generators)
 - GR@PPA_4b + "W/Z + jets", "6-body top-pair" etc.
 - Coming soon (debugging)

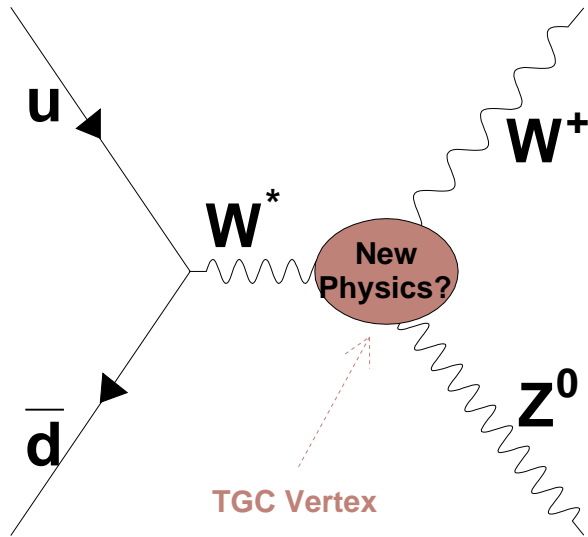
■ NLO generator

- ⊗ Test of ideas using the DY process
 - Y. Kurihara et al., Nucl. Phys. B654 (2003) 301
 - **Loop-corrected ME** generation by GRACE
 - **LL-subtraction** method to avoid double counts
 - ⊗ An application to LO processes is being tested with the Wisconsin group.
 - Appropriate negative-weight treatment in event generation

■ Initial-state Parton Shower

- ⊗ **X-deterministic forward evolution**
 - A new idea of an efficient forward evolution
 - ⊗ In the above report by Kurihara et al.
- ⊗ **NLL (Next-to-Leading Log) parton shower**
 - Theoretical formulae are ready.
 - ⊗ T. Sugiura, Prog. Theor. Phys. 107, 1163 (2002)
 - A simple MC implementation was tested.

Probing the Triple Gauge-boson Couplings



- non-abelian $SU(2)_L \times U(1)_Y$ gauge group (foundation of SM!)

→ $WW\gamma$ WWZ couplings

in $pp \rightarrow W\gamma, WZ, WW$

→ $ZZ\gamma$ and ZZZ couplings

in $pp \rightarrow ZZ, Z\gamma$

- each Lagrangian is written as a **model independent** parametrization.
- **Probe tool**: sensitive to low energy remnants of new physics operating at a higher scale
- **complement** to direct searches

Ongoing Studies: TGCs



- recent $pp \rightarrow ZZ, Z\gamma$ studies by S. Hassani

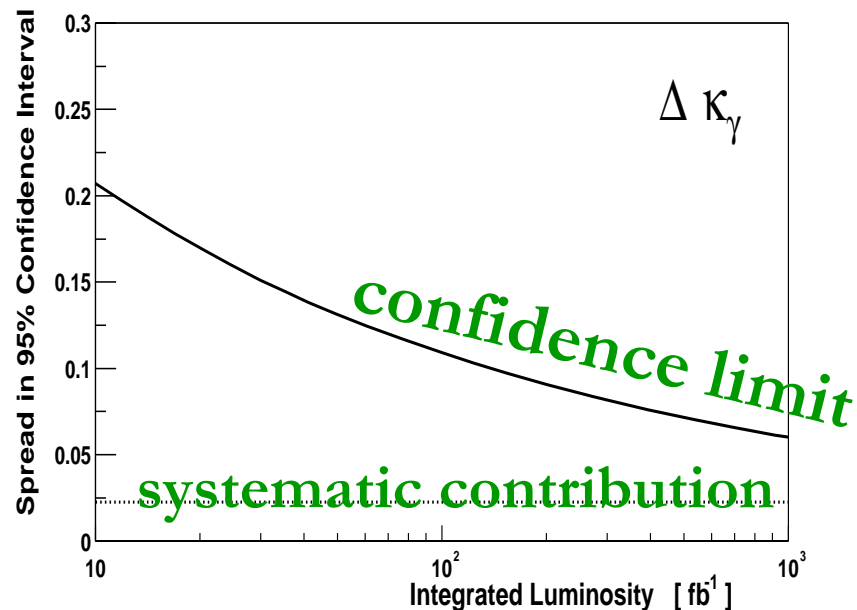
ATL-COM-PHYS-2002-012,013

- ⊗ effect of anomalous ZZV couplings is enhanced as much as energy⁶
- ⊗ LHC will have a huge advantage over previous measurements
 - possibly one of the first "precision measurements" to come out of SM group (??)

- $pp \rightarrow WZ, W\gamma$ studies by M. Dobbs

ATL-PHYS-2002-019,020

- ⊗ statistics will dominate LHC measurements because limits are always derived from the few events furthest out in the D tail



Ongoing Studies: TGCs in $pp \rightarrow WW$



- L. Simic (Belgrade) is confronting the challenging $WW \rightarrow l, \nu, l, \nu$ final state.

⊗ $t\bar{t}$ background is challenging!

process	W^+W^-	$t\bar{t}$	$W^\pm Z$	ZZ	Z
	NLO	NLO	LO	LO	LO
$\sigma_{tot}(\text{pb})$	110	833	26.7	11.1	4.8E4
$\sigma_{leptonic}(\text{pb})$	5.4	41.1	0.39	0.22	3.2E3

⊗ however, a careful choice of cuts, including a tight jet veto, brings the signal out

- two opposite charge leptons, $P_T(l^\pm) > 25 \text{ GeV}$, $|\eta| < 2.5$
- Z-mass constraint $|M_Z - M_{l+l-}| > 15 \text{ GeV}$
- $P_{T^{miss}} > 50 \text{ GeV}$
- Veto jets with $P_T(\text{jet}) > 10 \text{ GeV}$, $|\eta| < 3$

⊗ Events for 30 fb^{-1}

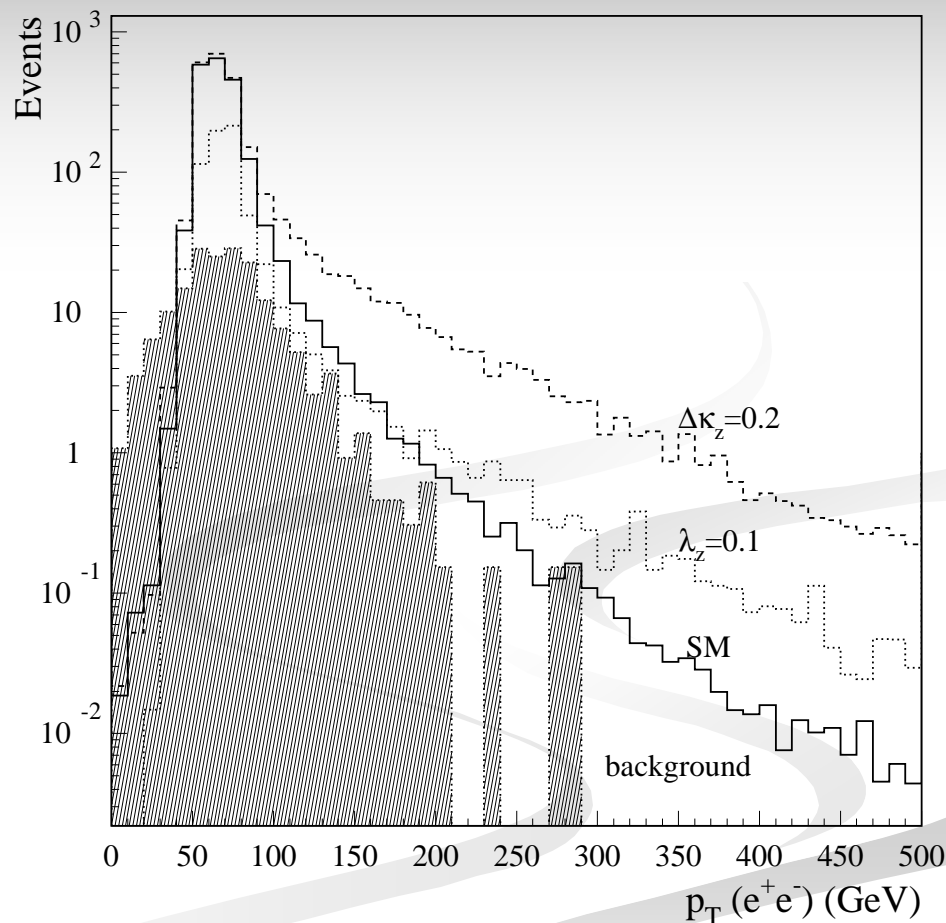
process	W^+W^-	$t\bar{t}$	$W^\pm Z$	ZZ	Z
events	7800	715	51	56	39

Ongoing Studies: TGCs in $pp \rightarrow WW$



- Limits are derived from the P_T of the electron-positron pair.
 - Conservative form factor:
 - ⊗ $\Lambda = 2 \text{ TeV}$
 - $L = 30 \text{ fb}^{-1}$
 - $-0.06 < \Delta\kappa < 0.1$
 - $-0.06 < \lambda < 0.06$
- (first look, statistics only)
assuming $WW\gamma \equiv WWZ$ couplings

This previously ignored channel provides competitive limits on the κ -type anomalous couplings.



Physics Commissioning/Validation



- distinguish here between detector \leftrightarrow physics validation
- Concentrate on *inclusive signature based samples* rather than processes for validating the physics
 - push the final comparison to require as little analysis/selection as possible
 - $e^\pm, P_{T^{\text{miss}}}$ rather than $W \rightarrow e^\pm, \nu$
 - nothing new here, just a different point of view.
- choose signatures which are dominated by (if possible few) well understood SM processes
 - but which might exhibit enhanced sensitivity to MC parameters & PDFs.
- usual game \rightarrow get an (relatively!) unbiased knowledge of one distribution by triggering on another.
- for each signature, measure kinematical properties and cross-sections
 - \rightarrow to validate our understanding of the physics environment
 - \rightarrow TUNE the Monte Carlos
- * Eventual extension to CDF style signature based (model independent) searches.

Inclusive Signature Based Samples



- charged particle distributions (from min. bias)
 - P_T and η from random triggers
(10M events, 1 year at 1Hz, 3 days at 100Hz)
- single & di-electron/muon distributions
- isolated photon distributions from γ + jet
- jet distributions
- inclusive spectra of resonances ($W, Z, Y, J/\Psi, \eta, \pi^0$)
- e/μ + N jets (i.e. W, Z + N-jets)

First Measurements / “Papers”



- 1st Collisions, inelastic event structure
 - ⊗ minimum bias, basic energy flow and charged/identified particle spectra
- Inclusive jet production
 - ⊗ angular distributions, multi-jet production
 - ⊗ Observation of jets with $E_T > 1 \text{ TeV}$ and $M(j,j) > 1 \text{ TeV}$
- Inclusive lepton spectra
 - ⊗ constrain production processes and pdf's
- Inclusive production of W and Z
 - ⊗ ratio of production cross-sections, lepton flavours
 - ⊗ QCD recoil: $P_T(Z/W)$, and $P_T(l_{\pm})$
- Observation of high mass lepton pairs
- Inclusive photon production
 - ⊗ measure PDF(gluon), combine w/ flavour tag to measure PDF(b)
- Heavy flavour (tt , bb) cross sections (top, beauty groups)
- First attempts for precision physics
 - ⊗ TGC production of $ZZ/Z\gamma$ (??)
 - ⊗ W -charge asymmetry
 - ⊗ observation of A_{FB}

Conclusions



- Several new/exciting SM studies underway
(min bias, $P_T(Z)$, PDFs, direct photon, WW TGC & Scattering, VHM)
since the formation of the SM group last year.
- Regardless of which LHC physics excites you most,
ATLAS (you!) will be crunching on SM topics during the
first year(s).
 - ⊗ there is a disproportionately small number of people working on
SM topics... *why not get involved now?*
- The first ATLAS papers will likely aim at proving our
understanding of the LHC physics environment in the
regime where SM is reliable.
 - prove our understanding of the detector and the physics environment.
→ *to be followed by the discovery papers.*